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Canada - Saskatchewan Renewables — Conservation Demonstration Program

Final Report

84- 4909 /

CANADA-SASKATCHEWAN CONSERVATION AND RENEWABLE ENERGY DEMONSTRATION AGREEMENT

On March 18, 1980, the governments of Canada and Saskatchewan entered into a Conservation and Renewable Energy Demonstration Agreement. The Agreement, which terminates March 31, 1984, funds the development and demonstration of a wide range of conservation and renewable energy technologies. The program is funded on an equal cost-shared basis by Canada and Saskatchewan, and is administered by Saskatchewan.

The objectives of CREDA are:

- To develop and demonstrate promising new technologies which exploit renewable energy resources, conserve energy, or make its use more efficient;
- To create employment in new or existing industries;
- To develop broad public awareness of the potential of renewable energy and energy conservation technologies.

This report outlines the results of a project funded by the Government of Saskatchewan as represented by Saskatchewan Energy and Mines, and the Government of Canada as represented by Energy, Mines and Resources Canada, under the terms of the Renewables-Conservation Demonstration Program, and contracted with the party identified herein.

However, neither the Government of Saskatchewan as represented by Saskatchewan Energy and Mines, nor the Government of Canada as represented by Energy, Mines and Resources Canada, accept liability for any errors, omissions, or inaccuracies that may; be included in or derived from this report, nor do they assume any liability with respect to the use of, or actions resulting from the use of, any information contained in this report.

Energy Audit: North Battleford Civic Centre

Retrofit of Recreation Facilities — Phase I

Final Technical Report
on a Renewables-Conservation Demonstration Program Project

Conducted By

Saskmont Engineering Company Limited

And Supported By

Saskatchewan Energy and Mines
and
Energy Mines and Resources Canada

Project Leader: Brian George

Miscellaneous
Report FP-10

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Executive Summary - Conclusions and Recommendations

In the Spring of 1982, Saskmont Engineering Company Limited conducted an energy audit of the Civic Centre in North Battleford, Saskatchewan. The results of that audit are summarized herein.

The Civic Centre was built in 1961, containing about 49,000 square feet of skating surface, bleachers, recreational and service areas. Three steam heated forced air systems heat the majority of the building.

Table 1.0 summarizes the implementation costs, energy saving, dollar saving and payback period of energy conservation measures identified in this report. Actual total savings may be less than the sum of the individual returns since some measures diminish the return yielded by others.

A great amount of energy can be conserved by modifying the main heating systems as noted in Items 24, 28 and 32. These items are recommended despite the longer payback periods.

Implementation of the following items with a payback period within 10 years is strongly recommended: 1, 2, 3, 4, 5, 6, 7, 10, 11, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25 and 36. The following items should be contemplated, although they yield a payback of greater than ten years: 26, 28, 29, 30 and 31. The following items should be implemented as maintenance items: 8, 9, 12, 16, 17, 32 and 34. Items 33 and 35 are operational items.

The strongly recommended measures will yield a first year return of $5,854.81. With a capital expenditure of $23,250 a 35% rate of return will be realized.

Table 1.0 - Summary of Energy Conservation Measures

Item	Description	Capital Cost	Energy Saving (yr)	Dollar Saving (yr)	Payback (yrs)
	Operation Items				
1.	Switching Water Circulator P-2	N/C	2470 EKWH	$ 29	Immed.
2.	Reduce Hot Water Temperature	N/C	1.2×10^4 C.F.	$ 36	Immed.
3.	Reduce Thermostat Setpoint	N/C	----	---	Immed.
4.	Gas Fired Water Heater H-1	N/C	1500 C.F.	$ 5	Immed.
5.	Ambulance Room Window	N/C	580 C.F.	$ 1.7	Immed.
8.	Descale Evaporative Condenser CT-1	$ 400	---	---	Done
9.	Upper Lobby Fan Unit F-2	Maint.	---	---	---
12.	Exhaust Air Dampers	Maint.	---	---	---
16.	Unit Heater Fan	Maint.	---	---	---
17.	Leaking Plumbing Fixtures	Maint.	---	---	---
26.	Ductwork Repairs	Maint.	---	---	---
33.	Changeroom Door Closers	$ 100	---	---	---
34.	Control Air Dryer	$2,000	---	---	---
	Architectural Items				
6.	Caulk South Wall	$ 50	5.3×10^4 C.F.	$ 160	0.3
18.	Weatherstrip Emergency Doors	$ 700	4.1×10^4 C.F.	$ 120	5.6
20.	Weatherstrip Front Doors	$ 500	2.3×10^4 C.F.	$ 70	7.4
21.	Repair Rink Service Door	$3,000	1.3×10^5 C.F.	$ 390	7.7
23.	Insulate Rink Glazing	$10,000	3.59×10^5 C.F.	$1,070	9.3
25.	Caulk & W/S Windows	$1,000	3.4×10^4 C.F.	$ 105	9.6
31.	Window Insulation	$1,500	3.5×10^4 C.F.	$ 105	14.3
35.	Concrete Block Sealer	$7,600	1.0×10^5 C.F.	$ 310	24.8

Table 1.0 - Summary of Energy Conservation Measures
(Cont'd)

Item	Description	Capital Cost	Energy Saving (yr)	Dollar Saving (yr)	Payback (yrs)
	Mechanical Items				
36.	Infrared Heaters in Arena Area	[illegible]	[illegible]	[illegible]	[illegible]
7.	Brine Pump Cycling P-7	$1,000	5.4×10^4 kWh	$1,004	1.0
13.	Insulate Steam Piping	$3,500	2.9×10^5 C.F.	$ 867	4.1
15.	Radiation Control R-1, 2 and 3	$ 300	2.1×10^4 C.F.	$ 62	4.8
22.	Equipment Waste Heat	$2,000	2.0×10^4 EKWH	$ 220	9.1
24.	Lounge Ventilation System F-3	$4,900	4.4×10^4 EKWH	$ 517	9.5
28.	Arena Ventilation Unit F-1	$17,000	4.97×10^5 C.F.	$1,490	11.4
29.	Reinsulate Ducting	$1,500	4.1×10^4 C.F.	$ 123	12.2
30.	Insulate D.H.W. Piping	$1,300	3×10^4 C.F.	$ 92	14.1
32.	Lobby Ventilation System F-2	$11,500	6.97×10^4 EKWH	$ 784	14.7
	Electrical Items				
10.	Demand Control	$1,500	18.8 KVA	$1,000	1.5
11.	Parking Lot Lighting	$ 500	1.3×10^4 kWh	$ 240	2.0
14.	Change Corridor Lighting	$ 0.5	6 kWh	$ 0.112	4.5
19.	Bleacher Lighting	$3,500	1.93×10^3 kWh	$ 389	9.0
27.	Ice Surface Lighting	$14,340	1.5×10^4 kWh	$1,142	12.6

1. INTRODUCTION

1.1 Scope of Work

In the spring of 1982, Saskmont Engineering Company Limited was commissioned by Saskatchewan Mineral Resources to conduct an energy audit of the North Battleford arena.

The scope of the project included the following:

1. Collect climatic data for the North Battleford area.
2. Analyze energy consumption in the past three years with attention to growth trends and monthly cycles.
3. Study the building and mechanical and electrical infrastructure.
4. Study the operation and maintenance, and use of the building, with discussion with building personnel.
5. Identify potential energy conservation measures.
6. Identify the economics of implementing each measure.
7. Prepare a final report encompassing all the above.

Subsequent to the issue of the contract, a request was made for an infrared scan of the building. This was subcontracted to Thermal Focus Consultants of Saskatoon.

1.2 Overview of the Complex

The Civic Centre was built in 1961. It includes about 32,500 $ft.^2$ of rink and bleacher area, 3900 $ft.^2$ of change room area, and 12,500 $ft.^2$ of recreation and service area. See Figure 1.1 for the location of the complex within North Battleford.

The roof was rebuilt several years ago. Several inches of foil face fiberglass insulation were added at that time.

An artificial ice plant was installed in 1974.

A fire detection and alarm system was added recently.

1.3 Climatic Data

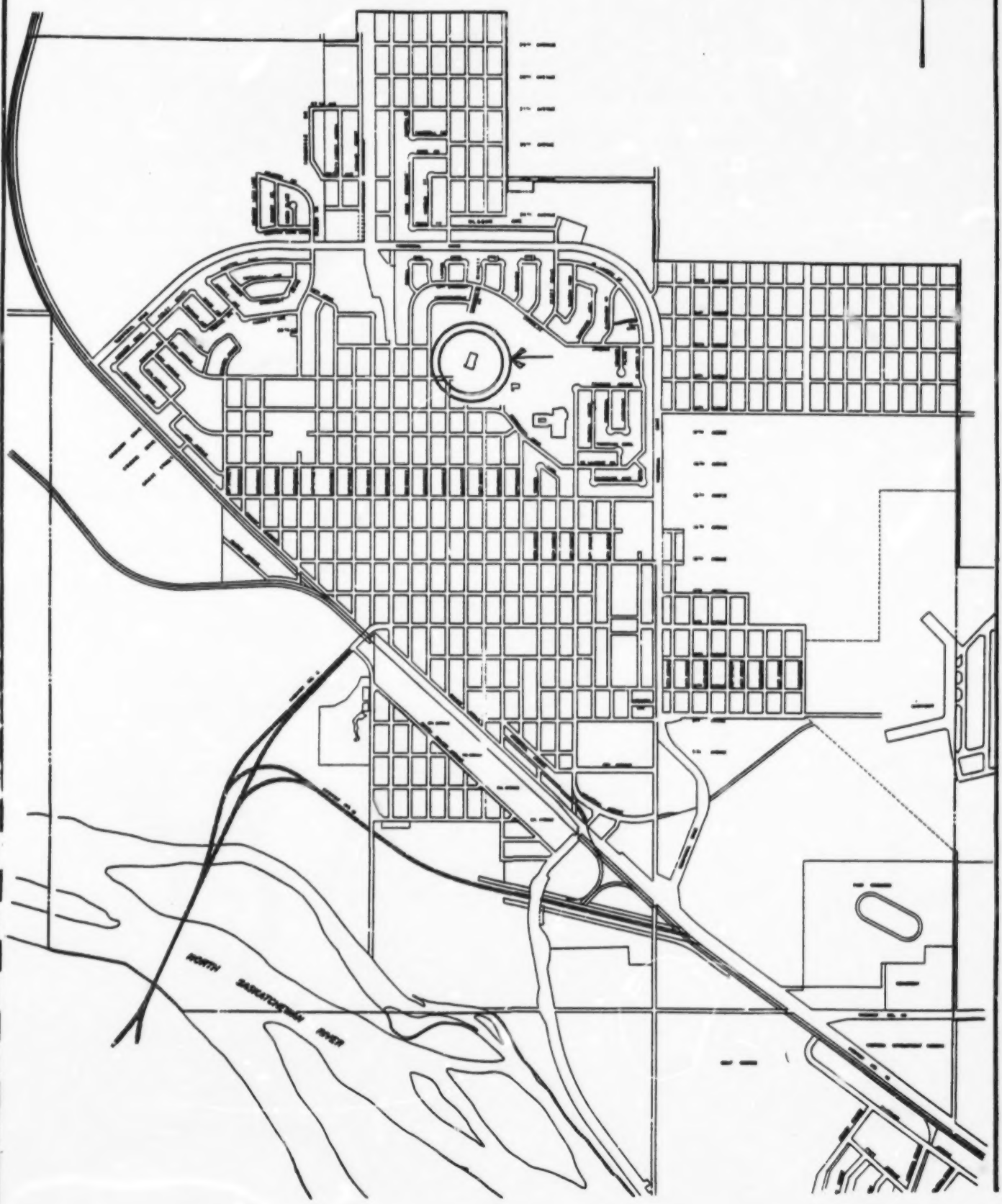
North Battleford is situated at latitude 52° 46' North, 108° 15' west at an elevation 1796 feet above sea level.

In heat loss calculations, 10970 Fahrenheit Degree Days (65°F base) are used. In the rink area, heat loss calculations are based on 45°F Degree Days estimated at 5,650. Design dry bulb temperature is -30°F. The mean daily temperature range is 23°F.

Fig. 1.1

CITY OF

NORTH BATTLEFORD



1. INTRODUCTION (Cont'd)

1.4 Energy Usage

Energy consumption for the entire recreational site for the past three years is shown in Table 1.1. Note the electrical energy use also includes the clubhouse, pool, ball diamond and site lighting.

Natural gas consumption typically fluctuates with the weather trend of a given year. Electricity, however, has been consumed at an increasing rate in the past two years (8% in 1980, 2% in 1981). From Figures 1.2, 1.3 and 1.4, this appears to be largely due to variations in the length of the ice making season. Between 1979 and 1980 an increase in summer consumption is evident.

Demand charges have dropped to 0 in May of 1979, and in June of 1981. This is probably due to the absence of the ball diamond lighting and the ice plants in those months.

For the purposes of this report, published 1982 energy prices will be used.

Electricity Consumption	- 1.86¢ kW.h
Electricity Demand	- $6.65 kV.A
Gas Consumption	- 11.21¢ m^3 (29.9¢/100 C.F.)

2. INVESTIGATION

2.1 General

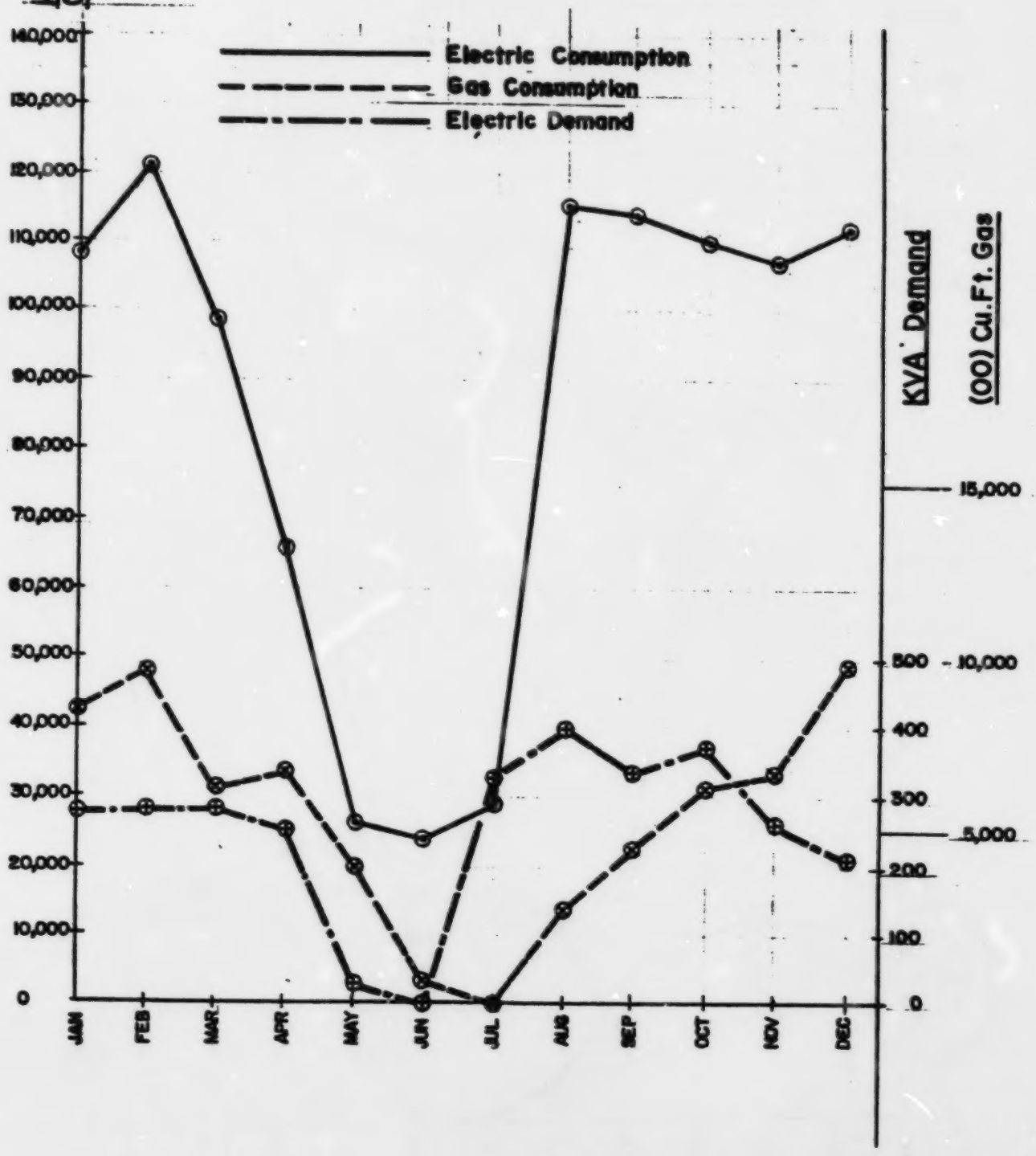
The building was examined on two separate occasions in March and April by Saskmont mechanical and electrical technicians and engineers.

The study included visual inspection of the building and system operations, and testing of system components. Photographs were taken to record visible problem areas.

The architectural, mechanical and electrical design drawings were obtained and examined. All plans were very close to actual construction. Additions to the floor area have been noted on the floor plan. See Figures 2.1 and 2.2.

No details were available of the recent roof reconstruction or second floor air conditioning system retrofit.

Fig. I.2 : 1981 Electricity/Gas Consumption



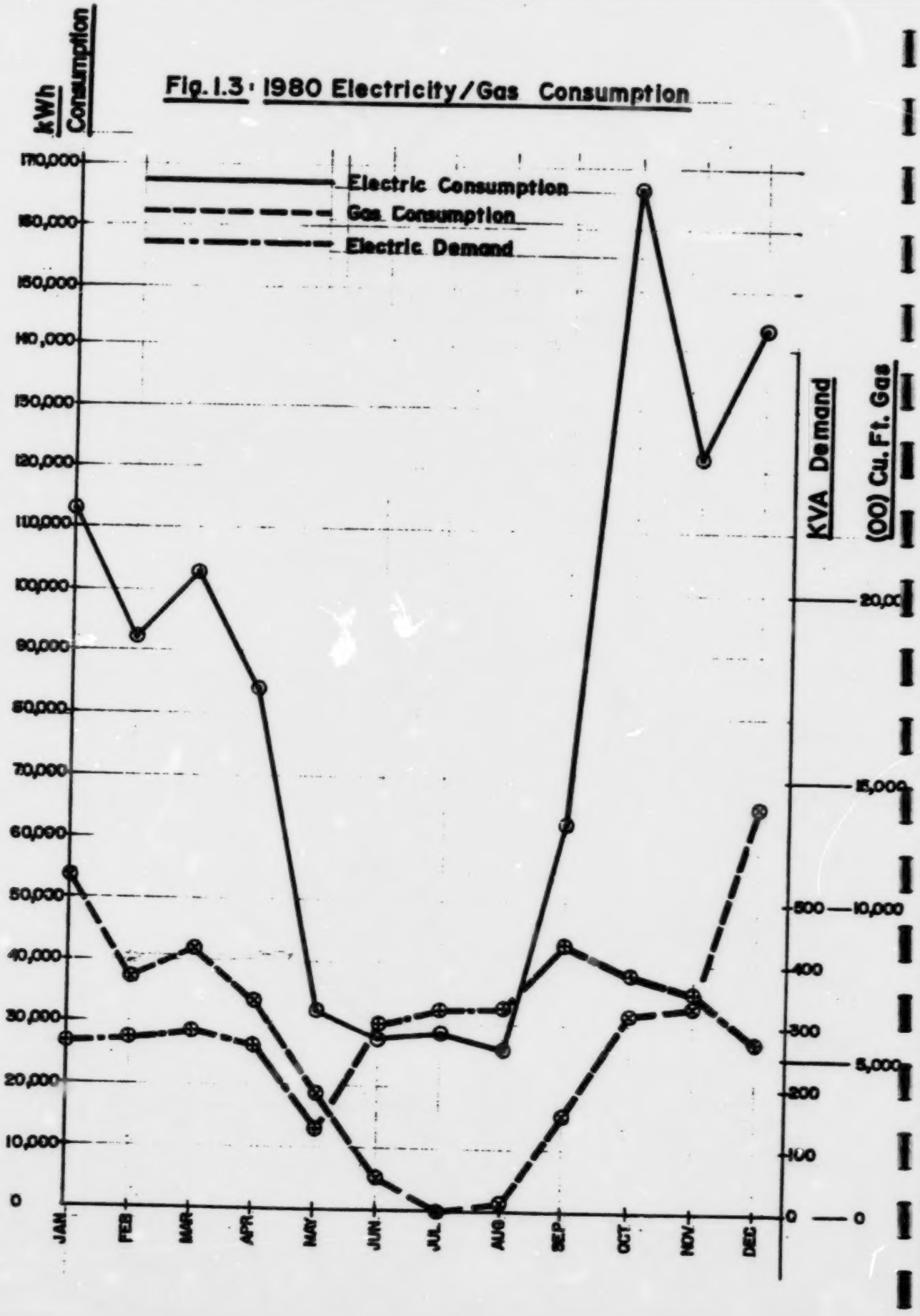


Fig. 1.3 : 1980 Electricity / Gas Consumption
kWh Consumption
Electric Consumption
Gas Consumption
Electric Demand
KVA Demand
(00) Cu. Ft. Gas
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
20,000
15,000
10,000
5,000
0
800
400
300
200
100
0
JAN
FEB
MAR
APR
MAY
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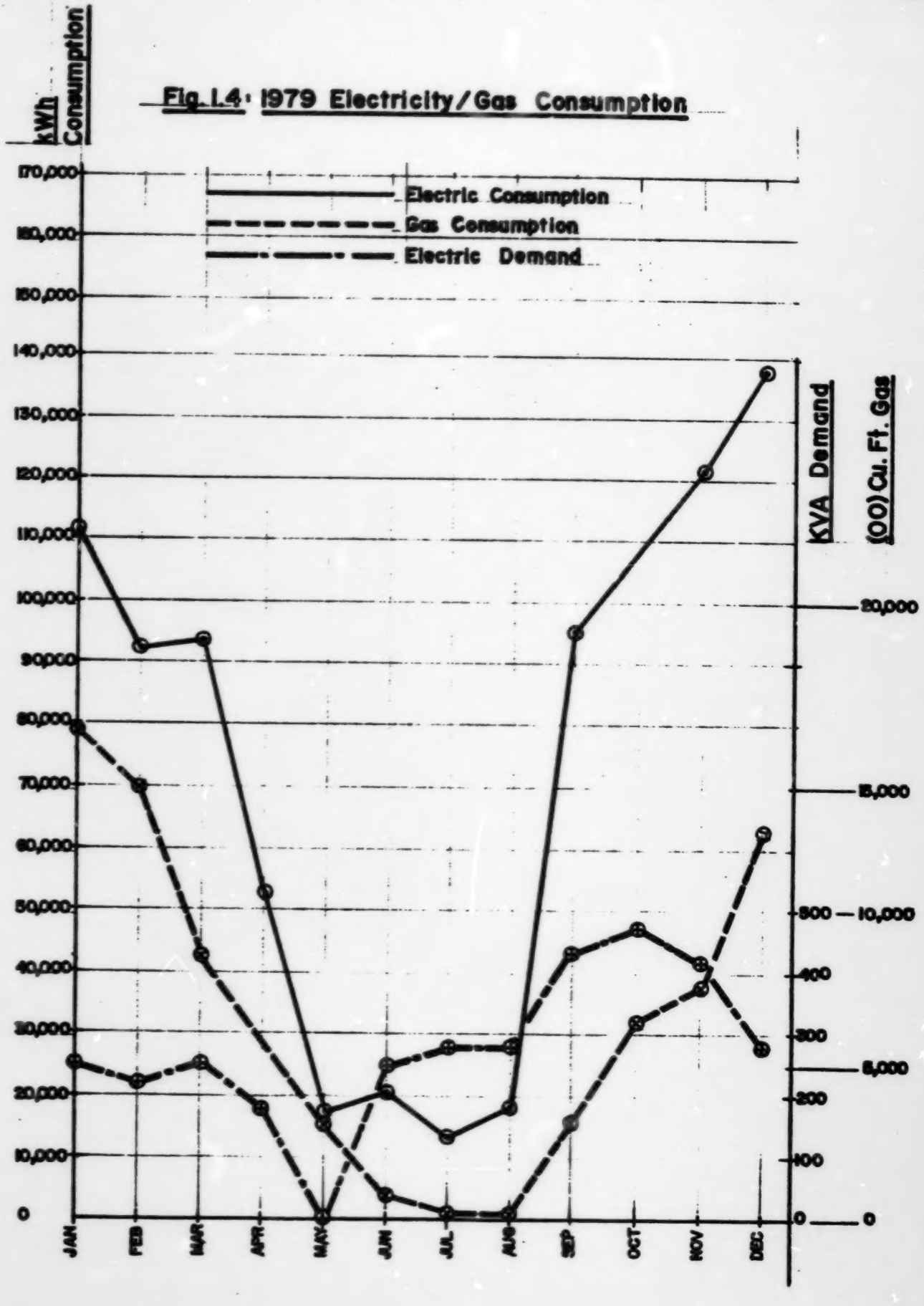


Fig. 1.4: 1979 Electricity / Gas Consumption
kWh Consumption
Electric Consumption
Gas Consumption
Electric Demand
170,000
160,000
150,000
140,000
130,000
120,000
110,000
100,000
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
KVA Demand
(00) Cu. Ft. Gas
20,000
15,000
500
10,000
400
300
5,000
200
100
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

Table 1.1 - Historic Energy Consumption

	1979		1980		1981	
	Electricity	Gas	Electricity	Gas	Electricity	Gas
January	112,800	15,782	113,400	10,856	109,200	8,614
February	94,200	14,039	93,600	7,685	121,800	9,768
March	94,200	8,581	104,400	8,375	99,600	6,187
April	53,400	10,176	84,600	6,812	66,000	6,839
May	17,400	3,256	31,800	1,922	25,800	4,207
June	20,400	950	28,800	1,016	24,600	647
July	14,400	257	29,400	15	28,800	324
August	19,800	315	28,800	298	115,200	2,951
September	94,800	3,149	68,400	3,148	113,400	4,386
October	150,600	6,690	166,800	6,571	110,400	6,193
November	121,800	7,556	124,200	6,836	106,800	6,771
December	139,200	12,743	140,400	13,331	111,600	9,955
TOTALS	933,000	83,494	1,011,600	66,865	1,033,200	66,842

Electricity - kWh - 3 year average - 992,600 kWhrs

Gas - (100's) cu. ft. - 3 year average - 7,240,000 C.F.

Electricity - 18.0 EKWH/SF/YR *
Gas - 43.3 EKWH/SF/YR

Total - 61.3 EKWH/SF/YR **

* Swimming Pool, Parking Lot and Ball Field assumed average of 24,000 kWhrs.

** Equivalent kilowatt hour per square foot per year.

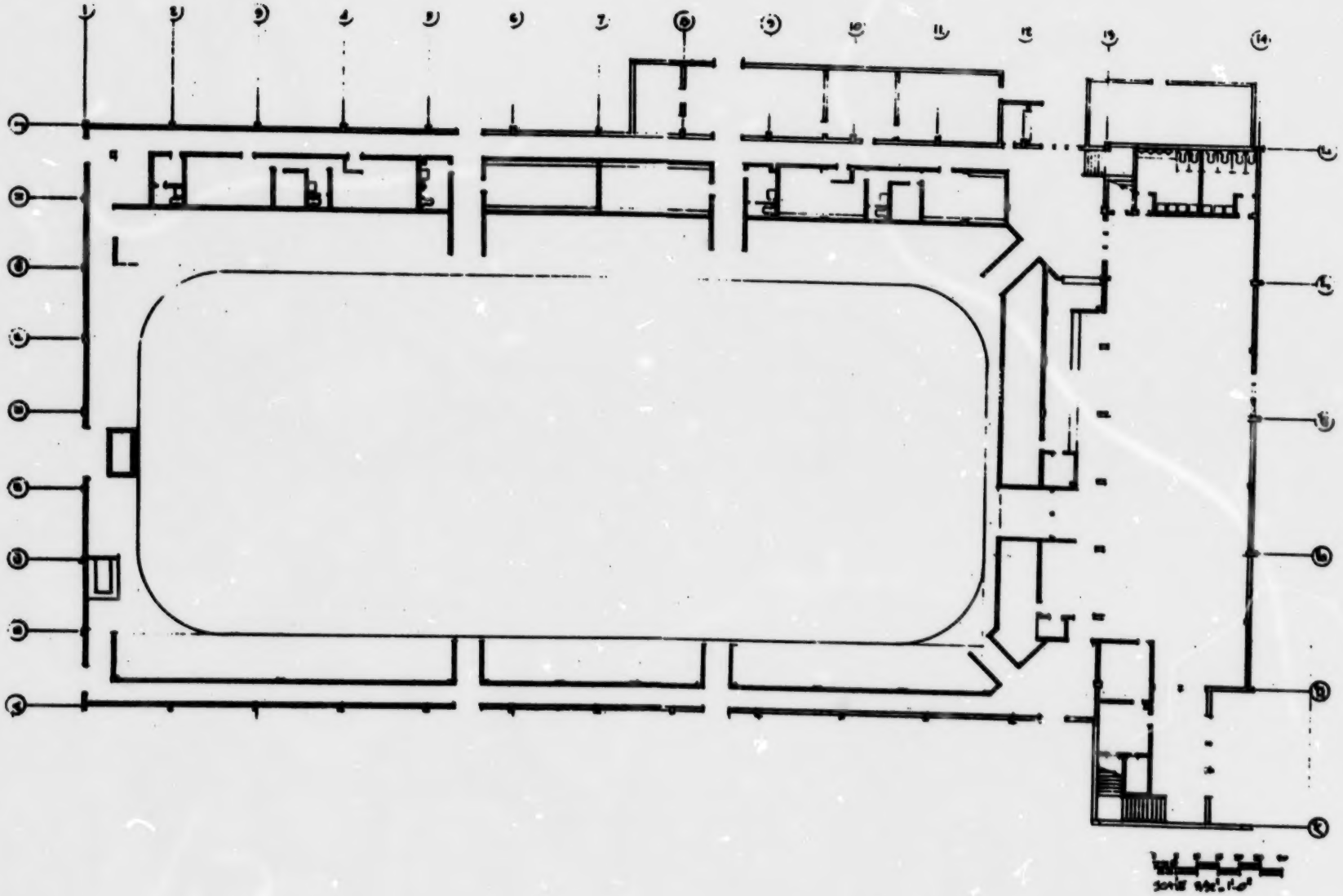
Table 1.2 - Historic Energy Costs

Electricity Costs

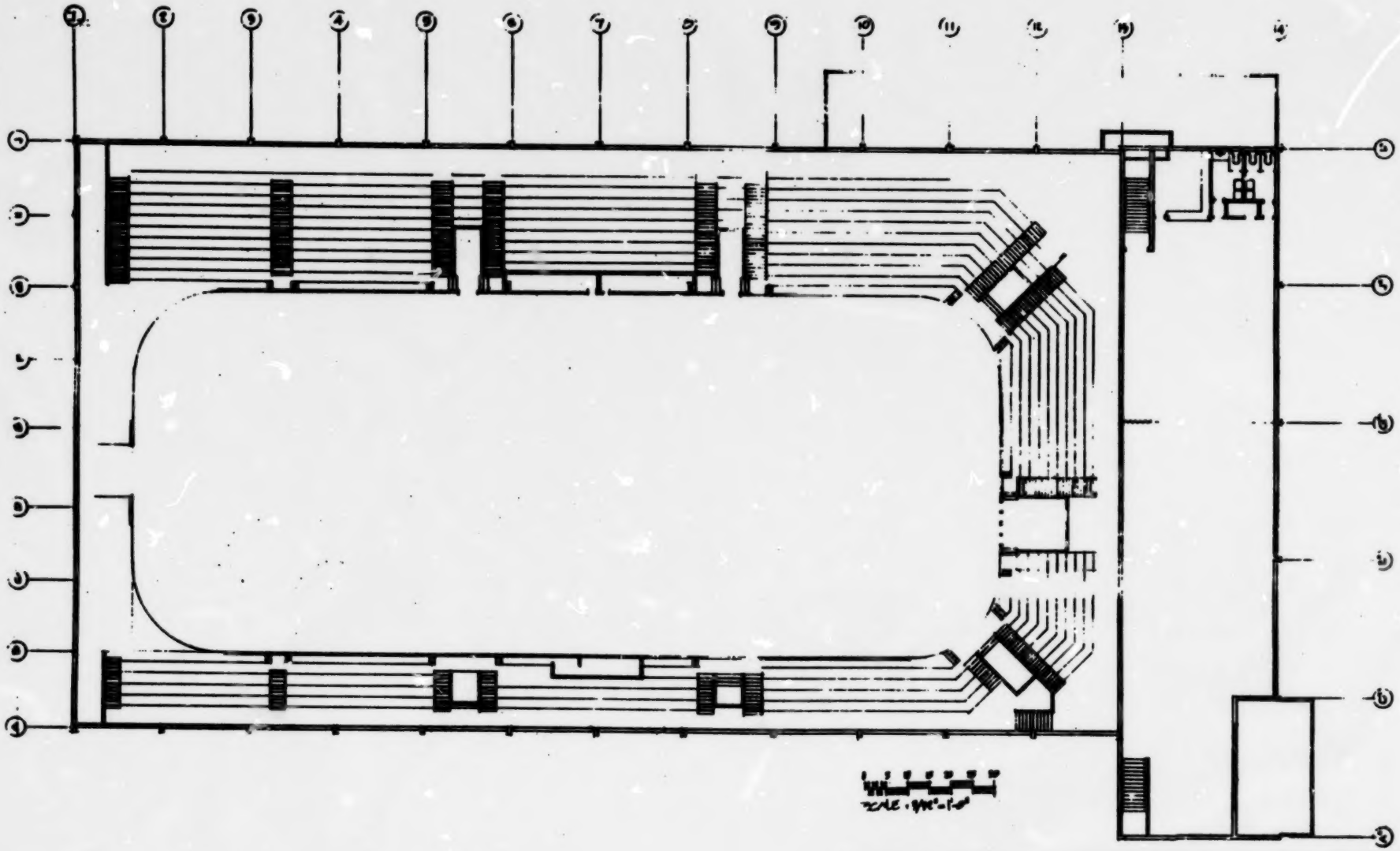
Effective Date	Breakdown	
February, 1979	First 300 kWh	- 1.9¢/kWh
	Balance	- 1.6¢/kWh
	Demand Rate	- $3.50/KVA
February, 1980	Usage Rate	- 1.7¢/kWh
	Demand Rate	- $4.60/KVA
February, 1981	Usage Rate	- 1.7¢/kWh
	Demand Rate	- $5.85/KVA

Natural Gas Costs

December, 1978	First 3 MCF	- $2.76/MCF
	Next 3 MCF	- $1.97/MCF
	Next 144 MCF	- $1.69/MCF
	Balance	- $1.68/MCF
March, 1979	First 3 MCF	- $2.75/MCF
	Next 3 MCF	- $1.96/MCF
	Next 144 MCF	- $1.69/MCF
	Balance	- $1.68/MCF
August, 1979	First 3 MCF	- $2.81/MCF
	Next 3 MCF	- $2.02/MCF
	Next 144 MCF	- $1.75/MCF
	Balance	- $1.74/MCF
February, 1980	First 3 MCF	- $2.90/MCF
	Next 3 MCF	- $2.11/MCF
	Next 144 MCF	- $1.82/MCF
	Balance	- $1.81/MCF
November, 1980	First 80 CM	- 12.64¢/CM
	Next 80 CM	- 9.68¢/CM
	Next 3850 CM	- 8.69¢/CM
	Balance	- 8.56¢/CM
May, 1981	First 80 CM	- 13.2¢/CM
	Next 80 CM	- 10.24¢/CM
	Next 3850 CM	- 9.16¢/CM
	Balance	- 9.12¢/CM
July, 1981	First 80 CM	- 13.76¢/CM
	Next 80 CM	- 10.80¢/CM
	Next 3850	- 9.72¢/CM
	Balance	- 9.68¢/CM



CITY OF NORTH BATTLEFORD	MAIN FLOOR PLAN
CIVIC CENTRE.	



CITY OF HOPITH BATTLEFORD	SECOND FLOOR PLAN
CIVIC CENTRE	

2. INVESTIGATION (Cont'd)

2.2 Architectural

The following approximate floor areas have been scaled from the drawings:

Rink and Bleachers		32,500 ft.^{2}
Changeroom Area		3,900 ft.^{2}
Recreation/Service Area		12,500 ft.^{2}
Total Floor Area	Approx.	48,900 ft.^{2}

Wall construction is typically 10 in. lightweight concrete block filled with expanded vermiculite. There was evidence of some insulation leakage through punctures in the block exterior. Some settlement of insulation remaining in the block cavities was noted. The insulation value of this wall is estimated at R4.15. A high incidence of block mortar cracking implies a high infiltration rate estimated at 3 cfh/ft.^{2} wall area.

Approximately 340 ft.^{2} of the south wall, and 960 ft.^{2} of the north wall are composed of a single layer of translucent fiberglass reinforced plastic. An additional 620 ft.^{2} of south wall consists of uninsulated 2" x 4" wood studs finished with gypsum board. The fiberglass has an insulation value of R0.9 and the uninsulated wood frame wall, R2.85. Infiltration through the fiberglass sheeting is estimated at 100 cfh per square foot area.

Roof construction is 3½ in. Foil Face Fiberglass Batting sandwiched between roof joists and a built-up wood roof. The insulation value is calculated at R13.

Windows are generally R1.7 double sealed units, with some operable awning units. Infiltration through the operable units is estimated to be 40 cu. ft./hr./lin. ft. of window crack length. The sealed units are estimated at 15 cu. ft. hr/lin. ft.

All exterior doors are heavily worn, and leaking badly. The east main entrance vestibule has two interior doors missing, resulting in substantially reduced effectiveness. The north overhead door has a two-inch airspace under, and numerous punctures and leaks throughout. In certain areas, the volume of snow filtering in through door cracks is enough that it must be shovelled out. Insulation value of the doors has been estimated at R1.5. Infiltration has been estimated at 140 cu. ft. hr./lin. ft. of crack.

2. INVESTIGATION (Cont'd)

2.3 Occupancy

The Civic Centre enjoys substantial usage during the winter. The rink and support facilities are used an average of 73 hours per week. Approximately 27% of this use is in the form of public, school and figure skating. The remaining time is devoted to hockey. The skating season is about 20 weeks.

The upstairs lounge is utilized for wedding receptions and assorted other social functions an average of 50 times per year at 5 hours each.

There is an indoor/outdoor rodeo lasting 2½ days each summer.

Attitude of the custodial staff towards energy conservation is considered excellent. During any one particular activitiy, unused portions of the complex are locked off and darkened.

2.4 Mechanical Systems

The primary system for air temperature control is composed of three forced air fan systems. A gas-fired steam boiler provides heat to the fan systems, unit heaters, one baseboard radiator, and the domestic hot water storage tank. One fan unit conditions the rink space, a second unit conditions the downstairs lobby, and a third, the upstairs lounge. A small cooling coil has been added into the upstairs lounge supply air duct, the packaged DX unit located on the roof of the boiler room. Separate day and night zone thermostats control each heating system. There is a manual day/night selector switch for each of the three fan systems. At the time of inspection the lounge systems were being operated with closed outdoor air dampers. This was accomplished by reducing pneumatic control pressure to 5½# to close dampers.

Changeroom and rink area washroom heating is accomplished with unit heaters. The heating coil is controlled by a thermostat, and fan by manual switch.

Shower head flows were recorded at 1.7 gal./min.

Corridors are generally unheated.

A gas fired domestic water heater provides hot water during times when the boiler is non-operational.

An Ammonia-Brine refrigeration plant maintains ice in the rink. Evaporative condensing coils are situated on an elevated rack on the east side of the building.

Rink area heating is controlled manually through switching the fan unit on or off with the circuit breaker.

2. INVESTIGATION (Cont'd)

2.5 Electrical Systems

The civic centre, ball park, swimming pool, parking lot and club-house complex is bulk metered.

Two electrical services serve the civic centre; a 600A, 120/208 volt, 3 phase, 4 wire overhead service for the building lighting and general power distribution and a 400A, 480V, 3 phase, 3 wire, overhead service for the ice plant.

The civic centre lighting is broken down as follows:

Ice Surface	- mercury vapour
Bleachers	- incandescent
Corridors and Dressing Rooms	- fluorescent
Storage Rooms and Washrooms	- incandescent
Lower Lobby	- fluorescent
Upper Lobby	- fluorescent and incandescent
Building Exterior	- mercury vapour

The fire alarm system consists of an Edwards 6500 series zoned, non-coded, supervised panel with heat, and smoke detectors and pull stations located throughout the building.

There is no emergency lighting in the building. Exit lighting is incandescent with no emergency back-up.

2. INVESTIGATIONS (Cont'd)

2.7 Equipment Schedule

Item	Description	Location	Data
F-1	Arena Supply	Arena Mezz.	Alpha 2-24 10 HP 18,500 CFM 1-1/4" S.P.
F-2	Lobby Supply	Boiler Room	Alpha 1-20 3 HP 5,600 CFM 1-1/4" S.P.
F-3	Lounge Supply	Boiler Room	Alpha 1-20 3 HP 5,600 CFM 1-1/2" S.P.
F-4	Lobby Exhaust	Above Rm 107	Tube Axial 2 HP 5,600 CFM 3/4" S.P.
F-5	Lounge Supply	Arena Mezz.	Tube Axial 2 HP 5,600 CFM 3/4" S.P.
F-6	Lobby Toilet Ex.	Above Rm. 111	Prop. Fan 12" 70W 850 CFM 1/3" S.P.
F-7	Lounge Toilet Ex.	Above Rm. 204	Prop. Fan 12" 70W 520 CFM 1/3" S.P.
F-8	Dressing Room Ex.	Above East Corr.	Prop. Fan 18" 240W 1,560 CFM 1/3" S.P.
F-9	Dressing Room Ex.	Above East Corr.	Prop. Fan 18" 240W 1,720 CFM 1/3" S.P.
F-10	Dressing Room Ex.	Above East Corr.	Prop. Fan 18" 240W 1,400 CFM 1/3" S.P.
F-11	Equip. Room Ex.	Room 119	Prop. Fan 12" 70W 1,200 CFM 1/3" S.P.
F-12	Kitchen Ex.	Room 202	Prop. Fan
B-1	Boiler	Boiler Room	15 psig steam 150 H.P.
P-1	Condensate Ret.	Boiler Room	37.5 GPM @ 25 psig
P-2	D.H.W. Circ.	Boiler Room	In-Line 1/10 H.P.
P-3	Boiler Feed Pump	Boiler Room	
P-6	Snow Melt Pit Pump	Arena West End	Submersible 1/3 HP 38 CPM @ 5 HP
P-7	Brine Pump	Equipment Room	Ebarra 150 SFM 25 HP 1750 RPM

2. INVESTIGATIONS (Cont'd)

2.7 Equipment Schedule (Cont'd)

Item	Description	Location	Data
P-8	Condenser Pump	Equipment Room	PACO 35E 280-186 3 HP 3450 RPM
C-1	Refrig. Unit	Equipment Room	CIMCO 2-75 HP Mycom 8A Comp. Ammonia System
C7-1	Cooling Tower	Outside Equip. Rm.	CIMCO 2-3 HP
CH-1	Ceiling Heater	Above Rm. 128	Proj. Heater 1/30 HP
CH-2	Ceiling Heater	Above Rm. 127	Proj. Heater 1/30 HP
CH-3	Ceiling Heater	Above Rm. 126	Proj. Heater 1/30 HP
CH-4	Ceiling Heater	Above Rm. 125	Proj. Heater 1/30 HP
CH-5	Ceiling Heater	Above Rm. 124	Proj. Heater 1/30 HP
CH-6	Ceiling Heater	Above Rm. 123	Proj. Heater 1/30 HP
UH-1	Unit Heater	Room 120	Horiz. Heater 1/20 HP
UH-2	Unit Heater	Room 119	Horiz. Heater 1/20 HP
UH-3	Unit Heater	Arena Mezz Sw Cor	Proj. Heater 1/30 HP
UH-4	Unit Heater	Above Rm 105	Horiz. Heater 1/30 HP
UH-5	Unit Heater	Above Rm 103	Horiz. Heater 1/20 HP
R-1	Radiation	Room 116	4'-0" Element - Wild
R-2	Radiation	Room 115	8'-0" Element - Wild
R-3	Radiation	Lounge S.W. Corner	42'-0" Element - Wild
FA-1	Furnace	First Aid Room	Gas Fired Upflow
H-1	D.H.W. Heater	Boiler Room	Gas Fired Standby D.H.W.

2. INVESTIGATIONS (Cont'd)

2.8 Lighting Schedule

	Area	Type of Fixture	No. of Fixture	Light Level Existing (fc)	Light Level Recommended (fc)
1.	East Entrance (Exterior)	Recessed Incand.	2 (1x150W)	--	-----
2.	East Entrance	Fluorescent	2 (2x40W)	--	-----
3.	East Lobby	Fluorescent	4 (2x40W)	15	15
4.	East Changeroom Corridor	Fluorescent	11 (2x40W)	15	15
5.	Changerooms (Typical)	Fluorescent	2 (2x40W)	10	15-20
6.	Changeroom Washroom (Typ)	Incandescent	1 (1x100W) 2 (1x200W)	10	15-20
7.	Eastside (Typ) Public Washroom	Incandescent	1 (1x100W) 1 (1x200W)	15	15-20
8.	Westide Corridor	Recessed Incand.	11 (1x150W)	--	15
9.	Westside Arena Lobby	Recessed Incand.	2 (1x150W)	--	15
10.	Ice Surface	Mercury Vapour	40 (1x400W)	30 (average)	50
11.	Concessions Lobby	Recessed Incand. Fluorescent	6 (1x150W) 28 (2x40W)	--	20
12.	Concessions	Incandescent	7 (1x150W)	--	30
13.	Public Washrooms (Concessions Area)	Recessed Incand.	2 (4x74W) 2 (1x150W)	--	15-20
14.	Office (West)	Fluorescent	1 (4x74W)	80 (on desk)	50
15.	Office (East)	Fluorescent	1 (4x74W)	80 (on desk)	50
16.	South Entrance (Interior)	Fluorescent	8 (1x40W)	--	-----
17.	South Entrance (Exterior)	Incand. (Quartz)	1 (1x500W)	--	-----

2. INVESTIGATIONS (Cont'd)

2.8 Lighting Schedule (Cont'd)

	Area	Type of Fixture	No. of Fixture	Light Level Existing (fc)	Light Level Recommended (fc)
18.	Building Exterior	Incandescent Mercury Vapour	7 (1x100W) 1 (1x400W) 5 (1x250W)	--	-----
19.	Bleachers	Incandescent	20 (1x300W)	--	10-15
20.	Auditorium	Recessed Incand. Fluorescent	18 (1x150W) 42 (2x40W) 3 (1x74W)	--	10-15
21.	Kitchen	Incandescent Fluorescent	2 (1x150W) 1 (2x74W)		30-50
22	Auditorium Washrooms	Recessed Incand.	4 (1x150W)	--	15-20

2. INVESTIGATION (Cont'd)

2.9 Energy Conservation Opportunities

.1 General

Potential energy conservation measures are labelled either "ECO", "Quick Fix", "Operational" or "Maintenance":

"ECO" - energy conservation opportunity normally requiring further investigation, design, and costing prior to implementation.

"Quick Fix" - items that may normally be implemented immediately requiring small capital expense and little further justification.

"Operational" - changes to operational procedures or setpoint.

"Maintenance" - areas where maintenance can be improved.

The description of work involved for each opportunity is at a "pre-conceptual" level. It is only intended to state the idea of the work not the actual details required. For the ECO's, several design options for each work may be available.

Capital costs are presented for each item along with an estimate Class:

Class I - ±10%
Class II - ±20%
Class III - ±30%
Class IV - less accurate than above.

Class I estimates are normally only available after complete design of a project.

Class II estimates are normally only available after total project scope is established.

Class III estimates are achievable in most cases at this stage, however in some cases due to a multitude of options available, Class IV estimates are used.

Energy savings are calculated in a formatted manner using the calculations given in Appendix "A". They are also given an estimate class:

Class I - ±10% estimate
Class II - ±25% estimate
Class III - ±50% estimate
Class IV - less accurate than above.

2. INVESTIGATION (Cont'd)

2.9 Energy Conservation Opportunities (Cont'd)

.2 Summary of Measures

Item	Description	Group	Payback (yrs)
1.	Switching Water Circulator P-2	Operational	Immed.
2.	Reduce Hot Water Temperature	Operational	Immed.
3.	Reduce Thermostat Setpoint	Operational	Immed.
4.	Gas Fired Water Heater H-1	Operational	Immed.
5.	Ambulance Room Window	Operational	Immed.
6.	Caulk South Wall	Quick Fix	0.3
7.	Brine Pump Cycling P-7	Quick Fix	1.0
8.	Descale Evaporative Condenser CT-1	Maintenance	Done
9.	Upper Lobby Fan Unit F-2	Maintenance	----
10.	Demand Control	E.C.O.	1.5
11.	Parking Lot Lighting	Quick Fix	2.0
12.	Exhaust Air Dampers	Maintenance	----
13.	Insulate Steam Piping	E.C.O.	4.1
14.	Change Corridor Lighting	E.C.O.	4.5
15.	Radiation Control R-1, 2 & 3	E.C.O.	4.8
16.	Unit Heater Fan	Maintenance	----
17.	Leaking Plumbing Fixtures	Maintenance	----
18.	Weatherstrip Emergency Doors	E.C.O.	5.6
19.	Bleacher Lighting	E.C.O.	6.2
20.	Weatherstrip Front Doors	E.C.O.	7.4
21.	Repair Rink Service Door	E.C.O.	7.7

2. INVESTIGATION (Cont'd)

2.9 Energy Conservation Opportunities (Cont'd)

.2 Summary of Measures (Cont'd)

Item	Description	Group	Payback (yrs)
22.	Equipment Waste Heat	E.C.O.	9.1
23.	Insulate Rink Glazing	E.C.O.	9.3
24.	Lounge Ventilation System F-3	E.C.O.	
25.	Caulk and W/S Windows	E.C.O.	9.6
26.	Ductwork Repairs	Maintenance	----
27.	Ice Surface Lighting	E.C.O.	10.7
28.	Arena Ventilation Unit F-1	E.C.O.	11.4
29.	Reinsulate Ducting	E.C.O.	12.2
30.	Insulate D.H.W. Piping	E.C.O.	14.1
31.	Window Insulation	E.C.O.	14.3
32.	Lobby Ventilation System F-2	E.C.O.	14.7
33.	Changeroom Door Closers	Maintenance	----
34.	Control Air Dryer	Operational	----
35.	Concrete Block Sealer	E.C.O.	24.8
36.	Infrared Heaters in Arena Area		

1. Switching Domestic Hot Water Circulator P-2

1.	Situation	.1	Domestic hot water is recirculated 24 hours per day year round, regardless of actual usage.
2.	Solution	.1	Operate recirculation pump only during periods of hot water demand.
		.2	Estimated Cost: Operational Item.
3.	Saving	.1	Heat loss from INSULATED 120°F domestic water piping: = (.2) (450) (50°F) ((365 x 24) - (73 x 52)) (30%) = 6701 cu. ft. gas. Calculation C-5. = $20
		.2	Motor Electrical Consumption: = (1/10) (1 kW/hp) ((365 x 24) - (73 x 52)) x 1.0 = 496 kWh. Calculation C-1. = $9
		.3	Total Saving = $29 Class II
4.	Remarks	.1	Operational Item.
		.2	Savings will be higher if item implemented on uninsulated, 140°F pipe.

2. Reduce Domestic Hot Water Temperature

1. Situation

.1 Domestic hot water is being maintained at 140°F. Heat loss through uninsulated piping and hot water storage tank is substantial.

2. Solution

.1 Reduce water temperature to 120°F.

3. Saving

.1 Reduced piping heat loss:

= (.74) (450°) (140-120) (250) (24) x 1.0
= 1.20×10^4 cu. ft. gas. Calculation C-5.
= $36

4. Remarks

.1 Operational Item.

.2 Effectiveness of this measure is reduced with insulated piping.

3. Reduce Thermostat Setpoint

1. Situation .1 Thermostat settings are above that required to maintain comfort conditions. Operation at warmer temperatures results in excess heat loss. Thermostat setpoints are:

   Upstairs lounge - day - 70°F
   - night - 63°F

   Lower lobby - day - 74°F
   - night - 61°F

2. Solution .1 Reduce setpoints of thermostats to 68°F. Calibrate to ensure that temperature is maintained.

3. Saving .1 $\frac{(\text{Old } T - \text{New } T)}{\text{Old } T} = \frac{(74-20) - (68-20)}{(74-20)} = .11$

   = about 11% reduction in conducted heat loss by reducing temperature from 74°F to 68°F.

4. Remarks .1 Operational Item.

4. Gas Fired Water Heater H-1

1. Situation

.1 An auxiliary gas fired water heater located in the boiler room to provide domestic hot water in periods of boiler shutdown was operating during the energy audit.

2. Solution

.1 Isolate the heater when the boiler is operating.

.2 Estimated Cost: Regular Maintenance Item.

3. Saving

.1 This measure reduced piping and tank heat losses in the boiler room and eliminates burner standby losses.

.2 Standby Losses:

= Gas usage by pilot ligt x day/year x hrs/day
= (1/10 CFH) (250) (24)
= 600 cu. ft. gas
= $2 Class III

With radiation heat losses, assume total of $5.00 yr. total cost. Class IV.

4. Remarks

.1 Operational Item.

.2 A detailed investigation of peak hot water demand may reveal that requirements are low enough that use of the large tank can be discontinued. The small tank, with better insulation, and self contained heater, would be much more efficient to operate.

5. Ambulance Room Window

1. Situation

.1 The inner pane of the horizontal slider window in the ambulance room was open at the time of the audit.

2. Solution

.1 Ensure the window remains closed.

3. Saving

.1 Conducted Heat Loss:

$$= \left(\frac{1}{R.9} - \frac{1}{R1.7}\right) (6)\ (10970)\ (24)\ (.7)$$

= 578 cu. ft. Calculation C-4.
= $1.70 year

4. Remarks

.1 Operational Item.

.2 When windows are found open, the cause should be investigated. (i.e. overheating - personnel do not know how to operate controls properly).

6. Caulk South Wall

1.	Situation	.1	Evidence of exfiltration was visible along the south block wall/soffit joint.
2.	Solution	.1	Caulk the corner of the ceiling and south wall inside the upstairs lobby.
		.2	Estimated Cost: $50 Class III
3.	Saving	.1	Reduced exfiltration of warm air through the crack to the exterior:
			= (140') ($3_4$7) (.50) (1.1) (10970) (24) (.7) = 5.25 x 10^4 cu. ft. Calculation C-3. = $157 Class III
4.	Remarks	.1	Quick Fix Item.

7. Brine Pump Cycling P-7

1. Situation

.1 Presently brine pump runs continuously during skating season.

.2 Compressors are cycled from brine return temperature sensor.

2. Solution

.1 Install an ice thermostat and start brine pump from the ice temperature.

Compressors to be cycled from brine return temperature.

.2 $1000 Class III estimate.

3. Saving

.1 Reduced energy use by cycling brine pump.

HP x 1 kW/HP x Est. hrs. operation x
% utilization factor

= 25 x 1 x 4,320 x 50%

= 54,000 kWh ann.

.2 Total Saving

Electricity 54,000 kWh annually $1,004
Class III estimate

4. Remarks

.1 Quick Fix Item.

.2 This item should be done before start-up of next season.

8. Descale Evaporative Condenser CT-1

1. Situation

.1 No water treatment was applied to the evaporative condenser is the past years.

.2 Evaporative condenser is very badly scaled reducing its capacity to approximately 60%.

2. Remarks

.1 Ensure water treatment of equipment remains as a priority and that descaling occurs as required.

9. Upper Lounge Fan Unit F-2

1.	Situation	.1	The cover plate on the upper level fan unit (farthest from mechanical room door) is missing. Supply air discharges into the mechanical room.
2.	Solution	.1	Replace cover.
3.	Saving	.1	Reduced heat loss to mechanical room area.
		.2	Increased air volume to building.
4.	Remarks	.1	Maintenance Item.

10. Demand Control

1. Situation

.1 Electrical demand charges have been partially controlled by management of the Ice Facility and the Ballpark Lights in conjunction with SPC's reading of the electrical meters.

.2 The greatest demand occurs when the ballpark lights are on and both ice plant compressors are operating.

.3 The electric service meter is on a pole in front of the building. Installing a demand control system at that location would be expensive.

2. Solution

.1 Monitor ballpark lights. When they are on automatically control ice plant as that second compressor will not start.

.2 Estimated Cost: $2,000 Class III.

3. Saving

.1 Reduced demand charges:

= 75 kW x 3 mo. x $6.65
= $1,500/year

4. Remarks

.1 Energy Conservation Opportunity.

.2 In conversation with the City of North Battleford officials, this is presently being controlled manually. The above ECO is estimated on automatic equipment, therefore eliminating the human factory and is proposed for consideration only.

11. Parking Lot Lighting

1. Situation

.1 Parking lot lighting is controlled by a photo-electric cell. Lights are switched on at nightfall and switch off with the morning light. The lights remain on through the early morning hours when the facility is not used.

2. Solution

.1 Connect a seven day timer in series with the photo-electric cell. The timer can be set to switch off lights from 1 a.m. onwards.

.2 Estimated Cost: $500 Class III.

3. Saving

.1 Throughout the year, electrical consumption could be reduced. Assume average hours on are 9 p.m. until 7 a.m. Switching lights off from 1 a.m. onwards will reduce parking lot lighting requirement by 6/10 hrs. = 60%.
If 10 - 1000 watt lights are involved, reduced energy consumption =

= (6 hrs) (6000 W) (365)
= 13140 kWh
= $244 Class III.

4. Remarks

.1 Quick Fix Item.

.2 No survey was made of the site lighting as this was beyond the scope of work, therefore exact number and wattage of lights should be confirmed.

12. Exhaust Fan Dampers

1.	Situation	.1	Backdraft dampers do not open properly when the fan unit is operating, resulting in inefficient system operation.
2.	Solution	.1	Repair and install weatherstripping, or replace with low leakage dampers.
3.	Saving	.1	Reduced motor electricity consumption through reduced static pressure.
		.2	Proper exhaust.
4.	Remarks	.1	Maintenance Item.

13. Insulate Steam Piping

1. Situation

.1 All steam and condensate piping in the east side underseat area is uninsulated, resulting in high heat loss through the block wall.

2. Solution

.1 Insulate the steam and condensate return (900 ft. @ 1¼" through 6" dia.) piping with rigid 1 in. fiberglass pipe insulation complete with all service jacket.

.2 Estimated Cost: $3,500.00 Class II.

3. Saving

.1 Reduced pipe heat loss to below bleacher area (assume 30% lost to outdoors through exterior wall):

= (1.58-0.30) x (900 x (200-60) x (250 x 24) x 0.30/1000
= 290,000 cu. ft. gas Class III. Calculation C-5.
= $867.

4. Remarks

.1 Energy Conservation Opportunity.

.2 The majority of piping is exposed in the underseat area and easily accessible.

14. Corridor Lighting

1. Situation

.1 Lighting now provided by vapour-tight fluorescent fixtures (2 lamp, 40 watt each).

2. Solution

.1 Replace existing fluorescent lamps with watt-miser type.

.2 Similar light level achieved.

.3 Cost of watt-miser lamp approximately $.50 more than standard lamp with 5 watts per lamp less energy consumption.

3. Savings

.1 Assume 60 hours/week and 20 weeks/year operation.

.2 Savings/year:

$$= \frac{5W \times 20\ wks \times 60\ hr/wk \times 1.86¢/kWh}{1000}$$

= 11.16¢ saving per lamp/year. Class III.

4. Remarks

.1 Energy Conservation Opportunity.

.2 Based on the preceding hourly assumptions the lamps could last for approximately 6.5 years.

.3 The existing fixtures should be cleaned minimum of once a year.

.4 Recommend that this measure be phased in (i.e. as lamps burn out replace with the watt-miser type).

.5 Demand charges saved are negligible.

13. Insulate Steam Piping

1.	Situation	.1	All steam and condensate piping in the east side underseat area is uninsulated, resulting in high heat loss through the block wall.
2.	Solution	.1	Insulate the steam and condensate return (900 ft. @ 1¼" through 6" dia.) piping with rigid 1 in. fiberglass pipe insulation complete with all service jacket.
		.2	Estimated Cost: $3,500.00 Class II.
3.	Saving	.1	Reduced pipe heat loss to below bleacher area (assume 30% lost to outdoors through exterior wall): = (1.58-0.30) x (900 x (200-60) x (250 x 24) x 0.30/1000 = 290,000 cu. ft. gas Class III. Calculation C-5. = $867.
4.	Remarks	.1	Energy Conservation Opportunity.
		.2	The majority of piping is exposed in the underseat area and easily accessible.

14. Corridor Lighting

1. Situation

.1 Lighting now provided by vapour-tight fluorescent fixtures (2 lamp, 40 watt each).

2. Solution

.1 Replace existing fluorescent lamps with watt-miser type.

.2 Similar light level achieved.

.3 Cost of watt-miser lamp approximately $.50 more than standard lamp with 5 watts per lamp less energy consumption.

3. Savings

.1 Assume 60 hours/week and 20 weeks/year operation.

.2 Savings/year:

$$= \frac{5W \times 20\ wks \times 60\ hr/wk \times 1.86¢/kWh}{1000}$$

= 11.16¢ saving per lamp/year. Class III.

4. Remarks

.1 Energy Conservation Opportunity.

.2 Based on the preceding hourly assumptions the lamps could last for approximately 6.5 years.

.3 The existing fixtures should be cleaned minimum of once a year.

.4 Recommend that this measure be phased in (i.e. as lamps burn out replace with the watt-miser type).

.5 Demand charges saved are negligible.

15. Thermostatic Radiation Control R-1, 2 and 3

1. Situation

.1 Upstairs lounge and vestibule radiation operate uncontrolled. This results in overheating, and excess heat loss to the outdoors.

2. Solution

.1 Install electric thermostat controlled valve on steam supply to radiators.

.2 Estimated Cost: $300 each Class IV.

Total Cost: $900.

3. Saving

.1 Increased comfort in occupied areas.

.2 Reduced temperatures resulting in reduced heat loss to outdoors. i.e.: front vestibule

Wall Heat Loss:

= 1/R4.15 x 495 x (10,970-6,170) x 24/1000
= 13,690 cu. ft. gas

Window Heat Loss:

= 1/R1.7 x 285 (10,970-6,170) x 24/1000
= 19,370 cu. ft. gas

Total:

= 33,060
= $99/year.

4. Remarks

.1 Energy Conservation Opportunity.

.2 There are three possible units for automatic control, unit in upstairs lounge is the only viable installation.

16. Unit Heater Fan

1.	Situation	.1	S.W. corner changeroom unit heater fan does not operate.
2.	Solution	.1	Repair unit.
3.	Saving	.1	Increased comfort to changeroom users.
4.	Remarks	.1	Maintenance Item.

17. Leaking Plumbing Fixtures

1.	Situation	.1	A urinal and a shower were found to be leaking at the time of the site investigation.
2.	Solution	.1	Repair leaking fixtures.
3.	Saving	.1	Reduced water consumption.
4.	Remarks	.1	Maintenance Item.

18. Weatherstrip Emergency Doors

1. Situation

.1 Outdoor air leaks in through cracks around doors, resulting in discomfort, heat loss, and in some areas, snow clearing costs.

2. Solution

.1 Weatherstrip all emergency doors with magnetic weatherstripping.

.2 Estimated Cost: $700 Class III.

3. Saving

.1 Infiltration heat loss reduced by 75%:

Assume: leakage at 140 CFH/lin. ft.
: crack 230 lin. ft.

$$= \left(\frac{140 \times 231}{60}\right) \times \frac{1.1 \times 10{,}970 \times 24}{1000} \times .75$$

= 117,100 cu. ft. gas. Calculation C-3.
= $350 Class III

4. Remarks

.1 Energy Conservation Opportunity.

.2 If weatherstripping cannot close air spaces, the doors should be reset, or replaced.

19. Bleacher Lighting

1. Situation

.1 Lighting now provided by incandescent lighting over seating and walkway areas of the arena.

2. Solution

.1 Replace existing incandescent suspended fixtures with fluorescent fixtures.

.2 Approximately the same light levels will be achieved.

.3 Estimated Cost: $3500 Class I.

3. Savings

.1 Electrical consumption and demand charges per year:

Incandescent:

$$= \frac{21 \text{ hrs}}{\text{wk}} \times \frac{20 \text{ wks}}{\text{yr}} \times 20 \text{ fix.} \times \frac{300\text{W}}{\text{fix.}} \times \frac{\$.0186}{\text{kWh}} +$$

$$\frac{\$6.65}{\text{KVA/mo.}} \times \frac{12 \text{ mo.}}{\text{yr}} \times \frac{300\text{W}}{\text{fix.}} \times \frac{20 \text{ fix.}}{1000}$$

= $525.00 per year

Fluorescent:

$$= \frac{21 \text{ hrs}}{\text{wk}} \times \frac{20 \text{ wks}}{\text{yr}} \times 30 \text{ fix.} \times \frac{47\text{W}}{\text{fix.}} \times \frac{\$.0186}{\text{kWh}} +$$

$$\frac{\$6.65}{\text{KVA/mo.}} \times \frac{12 \text{ mo.}}{\text{y4.}} \times \frac{47\text{W}}{.9\text{PF}} \times \frac{30 \text{ fix.}}{1000}$$

= $136.00 per year

Savings: approximate energy cost savings per year $389.00 Class III.

4. Remarks

.1 Energy Conservation Item.

.2 Number of fluorescent fixtures increased as single lamp fixtures were used in the calculation to give more general lighting over the bleacher area.

20. Weatherstrip Front Doors

1. Situation

.1 Main east vestibule doors are heavily worn. Two of the interior doors are open. All three exterior doors are very leaky. Door corners are rounded.

2. Solution

.1 Reset two inside doors, weatherstrip the three exterior doors, and caulk the glazing in the three exterior doors.

.2 Estimated Cost: $500 Class III.

3. Saving

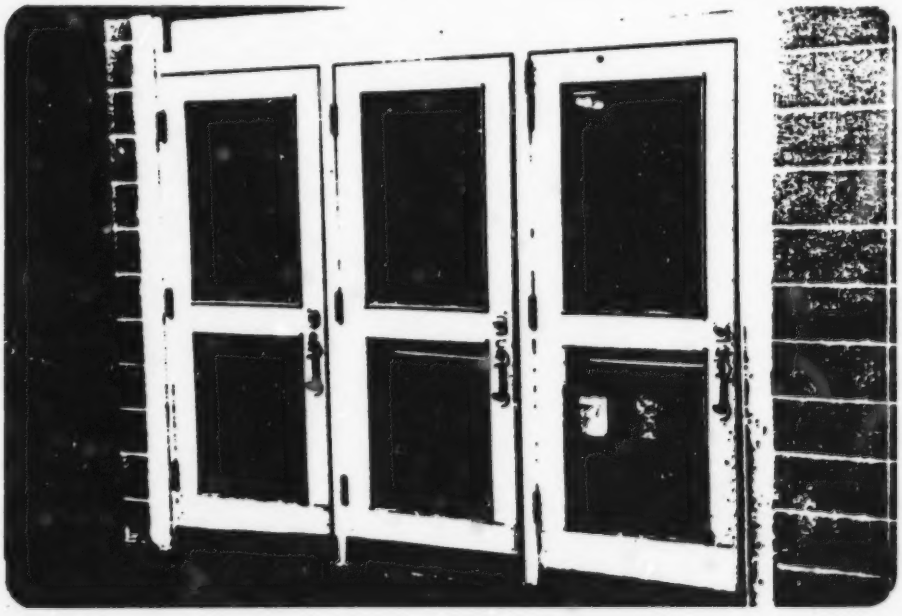
.1 Infiltration heat loss reduced 75% by weatherstripping, and the balance reduced by 30% by adding vestibule doors:

$$=[(140)\ (.75) + (140)\ (.25)\ (.3)]\ (60\ \text{lin ft})\ \frac{1.1/60}{(10970)\ (24)\ (\ 7)}$$
$$= 22{,}889\ \text{cu. ft. gas}$$
$$= \$68$$

4. Remarks

.1 Maintenance Item.

.2 $500 cost is due to bad shape of doors per unit.



21. Repair Rink Service Door

1. Situation

.1 The sectional wood door at the north end of the rink is badly worn. The hollow core door has many holes in the inner skin. A 2 in. air space exists between the door and floor. The weight of the door has pulled a column of block away from the pillar adjacent.

2. Solution

.1 Install a new insulated door with weatherstripping. Repair and seal the blockwork.

.2 Estimated Cost: $3,000 Class III.

3. Saving

.1 Reduced conducted heat loss:

$$= \left(\frac{1}{R3} - \frac{1}{R8}\right) (14 \times 12) (5650) (24) (.7)$$
$$= 3.322 \times 10^3 \text{ cu. ft.}$$ Calculation C-4.

.2 Reduced infiltration heat loss:

$$= (94') (15 \div 2) (1.1) (5650) (24) (.7)$$
$$= 1.276 \times 10^5 \text{ cu. ft.}$$ Calculation C-3.

.3 Total $= 1.31 \times 10^5$ cu. ft. gas
$= \$391$

4. Remarks

.1 Energy Conservation Opportunity.

22. Ice Making Equipment Waste Heat

1. Situation
   - .1 Evaporative condenser throws away ice making equipment heat to the outdoors.
2. Solution
   - .1 Recover a portion of this heat to preheat the domestic hot water.
   - .2 Estimated Cost: $2,000 Class IV.
3. Savings
   - .1 100% of the domestic hot water heating requirements:

     = (5 x 50) (4) (1.5 x 60) (70°) (10)/1000
     = 63,000 cu. ft. gas
     = $188
   - .2 Reduced evaporative condenser fan operation time:

     = (3,000 flh) (6 hp) (1 kWh) (10%)
     = 1800 kWh. Calculation C-1.
     = $33
   - .3 Total = $221 yr. Class IV.
4. Remarks
   - .1 Energy Conservation Opportunity.
   - .2 Recovered heat also has space heating applications.

23. Insulate Rink Wall Glazing

1. Situation

.1 Approximately 340 ft² of the south facing rink wall, and 960 ft² of the north wall is composed of a single layer of 5 oz. translucent fiberglass reinforced plastic. This material conducts a large amount of heat outdoors. The south section allows sunlight to strike the ice surface, decreasing quality control.

2. Solution

.1 Sheath and clad the exterior, install R12 insulation and poly vapour barrier, and finish the inside.

.2 Estimated Cost: $10,000 Class IV.

3. Saving

.1 Reduced conducted heat loss:

$= \left(\frac{1}{R0.9} - \frac{1}{R14}\right)$ (1300 ft²) (5,650) (24) (.7)/1000
= 128,292 cu. ft. gas. Calculation C-4.

.2 Reduced infiltration heat loss:

= (100/60) (1300 ft²) (1.1) (5,650) (24) (.7)/1000
= 230,750 cu. ft. gas. Calculation C-3.

.3 Total:

= 359,043 cu. ft. gas
= $1,070

4. Remarks

.1 Energy Conservation Opportunity.

.2 Improved lighting.

24. Lounge Ventilation System F-3

1. Situation

.1 The lounge unit is controlled by a Johnson Controls pneumatic control system.

.2 The system consists of a supply unit having both return and outside air which provides heating, cooling and ventilation to the space. Exhaust air is handled through an ancillary exhaust fan.

.3 The control system is supposed to operate through a day/night switch located in the manager's office and a heat/cool switch located in the mechanical room.

Day Operation

The fan runs continuously. The return air and outside air dampers are manually controlled. When the outside air damper is opened sufficiently the ancillary exhaust fan is supposed to start (in practise this control setting is disconnected and the exhaust fan is manually controlled. Its operation leads to complaints of noise).

In the heating mode the heating coil bypass damper is controlled by a room thermostat.

In the cooling mode a supply air duct sensor upstream of the cooling coil controls the operation of a packaged cooling unit.

Night Cycle

The outside air dampers are closed and the heating coil bypass dampers are set for 100% heating. The fan is cycled to maintain room temperatures through a night thermostat.

In practise night operation appears to be seldom used.

.4 Washroom exhaust fans exhaust continuously.

.5 The outside air dampers are not low leakage dampers. They probably leak at least 30%.

.6 Air leakage out of the shut-off ancillary fan is noticeable.

24. Lounge Ventilation System (Cont'd)

.2 Solution

.1 The existing day/night switch should be relabelled "occupied/unoccupied". The system should be on day cycle only when the area is to be occupied.

.2 Install a relief air louvre in the mechanical room and a return fan. Remove the existing ancillary exhaust fan and ductwork. Patch and seal holes in the rink and lounge wall. Install a mixed air temperature controller set at 55°F in the air handler to control return, relief and outside air dampers.

Estimated Cost: $3,000 Class II.

.3 Install a new low leakage damper in place of the existing outside air damper. Ensure new relief damper is low leakage.

Estimated Cost: $1,000 Class III.

.4 Controller in upstairs lounge for air conditioning unit.

Estimated Cost: $500 Class III.

.5 Interconnect the washroom exhaust fan wiring with the main system.

Estimated Cost: $300 Class III.

.6 Provide an 8 hour run timer to switch unit automatically from occupied to unoccupied cycle after at most 8 hours, unless reset.

Estimated Cost: $400 Class III.

.7 Unit should operate as follows:

Occupied Cycle

Fan to run continuously.

Washroom exhaust fans to run.

Heating to be supplied in accordance with room thermostat on heating mode.

On cooling mode, cooling to be supplied in accordance with room thermostat.

24. Lounge Ventilation System (Cont'd)

.2 Solution (Cont'd)

.7 (Cont'd)

Occupied Cycle Cont'd)

Outside air, return air and mixed air dampers to be controlled to a mixed air temperature of 60°F.

Unoccupied Cycle

Fan to run only when heating is required as controlled by a room thermostat.

Washroom exhaust fans to be off.

Cooling is off.

Outside air and relief dampers to be closed. Return air damper open.

.3 Savings

.1 Reduced fan motor electrical consumption due to unoccupied cycle (assumed 12 hrs day):

= (3) (1) (.80) (12 hrs/day) (250 days/year)
= 7200 kWh. Calculation C-1.
= $134

.2 Reduced outdoor air intake during unoccupied cycle:

= (1680) (1.1) (10970) (24) (.7) (9/24 hrs)/1000
= 127,720 CF gas. Calculation C-4.
= $383

.3 Reduced air conditioning load not calculated.

.4 Total Cost: $4,900
Annual Saving: $517
Energy Saving: 4.4×10^4 EKWH

.4 Remarks

.1 Energy Conservation Opportunity.

.2 The installation of a refrigeration air drier in the control air for the Arena Air Handler will also serve and improve this unit.

.3 Dependance on manual control will be reduced.

25. Caulk and Weatherstrip Windows

1. Situation
   .1 Windows permeate high amounts of infiltration air, resulting in high heat loss.

2. Solution
   .1 Caulk sealed units, and weatherstrip openable window units.

   .2 Estimated Cost: $1,000 Class III.

3. Saving
   .1 Infiltration reduced by 50%:

   Operable:

   $= (40 \text{ cfh}) (.5) (208') (1.1/60) (10970) (24) (.7)/1000$
   $= 1.38 \times 10^4$. Calculation C-3.

   Sealed:

   $= (15 \text{ cfh}) (.5) (852) (1.1/60) (10970) (24) (.7)/1000$
   $= 2.1 \times 10^4$. Calculation C-3.

   .2 Total $= 3.48 \times 10^4$ C.F.
   $= \$104$ Class III

4. Remarks
   .1 Energy Conservation Opportunity.

26. Ductwork Repairs

1.	Situation	.1	Supply air ducting in many areas has been damaged resulting in numerous leaks at joints.
2.	Solution	.1	Pull ducting into original position, and tape all joints to be air tight.
3.	Saving	.1	Restored efficiency of fan units, and increased heat delivery.
4.	Remarks	.1	Maintenance Item.

27. Ice Surface Lighting

1. Situation

.1 Lighting now provided by 40 - 400 watt mercury vapour lighting fixtures.

2. Solution

.1 Remove existing mercury vapour fixtures and replace with:

a) 400 watt metal halide
b) 250 watt high pressure sodium
c) Super High Output Fluorescent

.2 Approximately same light level achieved, using:

a) 28 - 400 watt metal halide
b) 30 - 250 watt high pressure sodium
c) 28 - Super High Output Fluorescent

3. Savings

.1 Electrical consumption assuming 1500 hours of operation per year:

a) Existing 400 watt mercury fixtures

$$\text{kWh/yr} = \frac{40 \text{ fix} \times 455 \text{ watts} \times 1500 \text{ hrs}}{1000}$$

$$= 27300 \text{ kWh/yr}$$

Cost = 27,300 x .0186 = $508.00 Class I

KVA demand charge

$$= \frac{40 \times 455\text{W} \times 12\text{m} \times 6.65/\text{KVA/mon.}}{.9 \text{ PF} \times 1000}$$

= $1,614.00 KVA demand/yr

Total operating cost (400 watt mercury vapour)
= $508.00 + $1,614.00 = $2,122.00 per yr.

b) New 400 watt metal halide fixtures

$$\text{kWh/yr} = \frac{28 \text{ fix} \times 460\text{W} \times 1500 \text{ hrs}}{1000}$$

$$= 19{,}320 \text{ kWh/yr}$$

Cost = 19,320 x .0186 = $360.00 Class I

KVA demand charge

$$= \frac{28 \times 460\text{W} \times 12\text{mo.} \times 6.65/\text{KVA/mo.}}{.9\text{PR} \times 1000}$$

= $1,142.00 KVA demand/yr.

Total operating cost (400 watt metal halide)
= $360.00 + $1,142.00 = $1,502.00 per year

27. Ice Surface Lighting (Cont'd)

3. Savings (Cont'd)

.1 (Cont'd)

c) New 250 watt high pressure sodium fixtures

$$\text{kWh/yr} = \frac{30 \text{ fix} \times 280\text{W} \times 1500 \text{ hrs}}{1000}$$

$$= 12{,}600 \text{ kWh/yr.}$$

Cost = 12,600 x .0186 = $235.00 Class I

KVA demand charge

$$= \frac{30 \times 280 \times 12 \text{ mo} \times 6.65/\text{KVA/mo}}{.9 \text{ PF} \times 1000}$$

= $745.00 KVA demand/year

Total operating cost (250 watt high pressure sodium)

= $235.00 + $745.00 = $980.00 per year

d) New Super High Output Fluorescent fixtures

$$\text{kWh/yr} = \frac{28 \text{ fix} \times 450\text{W} \times 1500 \text{ hrs}}{1000}$$

$$= 18{,}900 \text{ kWh/yr}$$

Cost = 18,900 x .0186 = $352.00 Class I

KVA demand charge

$$= \frac{28 \times 450\text{W} \times 12 \text{ mo} \times 6.65/\text{KVA/mo.}}{.9 \text{ PF} \times 1000}$$

= $1,117.00 KVA demand/yr.

Total operating cost (Super High Output Fluorescent)

= $352.00 + $1,117.00 = $1,469.00 per year

.2 Payback

a) Metal Halide - $16,800.00 installation cost

$$\frac{16800.00}{2122-1502} = 27.1 \text{ yrs.}$$

b) High Pressure Sodium - $14,340.00 installation cost

$$\frac{14{,}340.00}{2{,}122-980} = 18 \text{ yrs.}$$

c) Fluorescent - $7,000.00 installation cost

$$\frac{7{,}000.00}{2{,}122-1{,}469} = 10.7 \text{ yrs.}$$

4. Remarks

.1 Energy Conservation Opportunity.

.2 The preceding fixture types are based on achieving approximately the same light level as there is now over the ice surface (approximately 30 fc average).

27. Ice Surface Lighting (Cont'd)

4. Remarks (Cont'd)

.3 High pressure sodium lighting has an operating saving of approximately $1000.00 per year.

.4 Approximate light output of various light sources after 3,000 hours of operation are as follows:

a) Mercury Vapour - 87%
b) Metal Halide - 87%
c) Fluorescent - 87%
d) High Pressure Sodium - 97%

.5 50 foot candles of light in lieu of 30 foot candles are as follows:

a) Fixtures Required:

1) Metal Halide = 46
2) High Pressure Solium = 50
3) SHO Fluorescent = 46

b) Operating Costs Per Year:

1) Metal Halide = $2,493.00
2) High Pressure Sodium = $1,627.00
3) SHO Fluorescent = $2,440.00
4) Mercury Vapour = $3,522.00

c) Installation Costs:

1) Metal Halide = $27,890.00
2) High Pressure Sodium = $23,805.00
3) SHO Fluorescent = $11,620.00

.6 Recommend the use of high pressure sodium lighting because of lower operating costs and longer lamp life. If colour rendition is a concern, the number of high pressure sodium lamps could be decreased and additional fluorescent lighting added to provide proper colour balance.

.7 As an alternative, the existing mercury vapour fixtures (40) could be replaced, fixture for fixture, with the following, thus saving considerable installation costs:

a) 400 watt metal halide
- 45 foot candles average

b) 250 watt high pressure sodium
- 40 foot candles average

c) 400 watt high pressure sodium
- 67 foot candles average

28. Arena Ventilation Unit F-1

1. Situation

.1 The arena unit is controlled by a Johnson Controls pneumatic control system.

.2 The control system incorporates a freeze stat which has broken or is being disconnected.

.3 The control system is designed to operate through a day/night switch located in the manager's office.

Day Operation

The fan runs continuously. The mixed air temperature is supposed to be controlled to -8°F. In practise at that setpoint the system will intake 100% outside air anytime the ambient temperature is above -8°F and will achieve a mixture of outside air and return air below -8°F.

Since the average temperature in Saskatchewan is about 32°F the unit on day cycle will operate on 100% outside air most of the time.

The heating coil bypass dampers are controlled by a room thermostat located on an outside wall. Space temperature is supposed to be 45°F. In practise when ambient temperatures are low this is difficult to achieve.

Night Operation

The outside air damper closes, heating coil bypass dampers close, and face dampers open. The fan cycles to maintain the space temperature of the night thermostat.

In practise this setting is seldom achieved due to the erratic operation of the control system.

The fan is normally shut off at the circuit breaker panel.

If the fan does run on night cycle, leakage through the closed outside air dampers probably approaches 30%.

2. Solution

.1 Move the room thermostats from the outside wall to an inside wall. This will result in better sensing of space temperature.

Cost: $500 Class III.

28. Arena Ventilation Unit (Cont'd)

2. Solution (Cont'd)

.2 Replace the broken freeze stat on the unit.

Cost: $500 Class III.

.3 Take manual control of the mixed air dampers. 100% outside air would very seldom be required in the arena as occupancies are normally low. The outside air damper should remain closed for all but special high occupancy events (summer rodeo, play-off hockey, etc.).

Cost: $1,000 Class III.

.4 Install a low leakage outside air damper in place of the existing damper. Present damper probably leaks 30% when closed.

Cost: $3,000 Class III.

.5 Install ceiling destratification fans (ceiling propeller fans) over the bleacher areas to destratify the ceiling heat and improve arena comfort.

Approximately 10 fans would be required at $1,000 each.

Cost: $10,000. Class III estimate.

.6 Operate unit on night cycle as much as possible, avoid continuous fan operation.

.7 Consider installing CO_2 sensors to control outside air dampers automatically in lieu of manual control suggested in .4. Carbon dioxide levels are a measure of the need for outside air, by measurement, outside air use can be reduced to a minimum.

Cost: $5,000. Class III.

.8 Total Estimated Cost (minus CO_2 sensor): $17,000. Class IV.

3. Savings

.1 Moving the room thermostats results in no direct savings. The temperature sensed by the room thermostats will not be accurate unless they are moved.

.2 Replacing the broken freeze stat will not result in direct savings. It may protect the coil fan damage.

28. Arena Ventilation Unit (Cont'd)

3. Savings (Cont'd)

.3 Manual control of the outside air dampers will result in reduced heating load.

Assume present operation day cycle
2000 hours per year
Assume present outside air required
80% outside air
Assume manual control reduces outside air
to 30% (leakage through closed dampers)

= 1.1 x 18,500 cfm x (80%-30%) (5650) (24) (.7) (2000/8760)/1000
= 2.2×10^5 C.F. gas. Calculation C-3 Modified.
= $660

.4 Low leakage dampers would save an additional 30% outside air heating load.

= (1.1) x (18,500) (30%) (5650) (24) (.7) (2000/8760)/1000
= 1.32×10^5. Calculation C-3.
= $395

.5 Ceiling destratification fans would produce better comfort and result in energy saving through reduced heat loss through the roof.

= (31,460 ft^2) (.077) (55°-45°) (24) (250)
= 1.45×10^5 CF gas
= $434

.6 Operate unit on night cycle. This will be possible with the installation of a refrigerated air dryer.

.7 Installation of a CO_2 monitor will ensure an exact minimal amount of outdoor air is introduced to maintain a specified level of CO_2.

.8 Total Annual Energy Savings: 4.97×10^5 C.F. gas
Total Annual Dollar Saving: $1490

4. Remarks

.1 Energy Conservation Item.

.2 All items except CO_2 monitor are recommended.

29. Reinsulate Second Floor Supply Air Ducting

1. Situation
   - .1 Rigid foam insulation strapped to second floor lobby supply air ducting has partially fallen off.
2. Solution
   - .1 Remove existing insulation, tape all ductwork, and replace with proper duct insulation.
   - .2 Estimated Cost: $1500. Class IV.
3. Saving
   - .1 Reduced heat loss to the arena area:

$$= (1040)\left(\frac{1}{R2.5} - \frac{1}{R5}\right)(55)(200)(18)$$

$$= 4.12 \times 10^{4} \text{ cu. ft. gas}$$

$$= \$123 \text{ Class III}$$

4. Remarks
   - .1 Energy Conservation Opportunity.
   - .2 In summer, air conditioned duct heat gain would be reduced due to the insulation.
   - .3 The existing duct insulation is useless. The installation is unsightly and the use of uncovered styrofoam insulation for duct insulation is against most fire regulations.

30. Insulate Domestic Hot Water Piping

1.	Situation	.1	Domestic hot water supply and recirculate piping in the space above the changerooms loose heat to the space. An estimated 30% of this heat is conducted to the outdoors through the exterior block wall.
2.	Solution	.1	Insulate the piping with 1" rigid fiberglass pipe insulation complete with all service jacket.
		.2	Estimated Cost: $1300 Class III.
3.	Savings	.1	Conducted heat loss to outdoors: = (.74-.2) (450') (140-70°) (250 days) (24 hrs) (30%)/1000 = 3.06×10^4 cu. ft. gas. Calculation C-5. = $92 Class II
4.	Remarks	.1	Energy Conservation Opportunity.

31. Window Insulation

1.	Situation	.1	Upper and lower lobby facilities are seldom used during daylight hours. Large windows conduct heat to the outdoors throughout the winter and cause overheating in summer.
2.	Solution	.1	Add R-5 rigid insulation inside the glazing of non-operable windows, and finish the interior.
		.2	Estimated Cost: $1500 Class IV.
3.	Saving	.1	Comfort of occupants in summer.
		.2	Reduced air conditioning costs.
		.3	Reduced winter heat loss:

$$= \left(\frac{1}{R2} - \frac{1}{R8}\right)_4 (510\ ft^2)\ (10970)\ (24)\ (.7)/1000$$

$= 3.52 \times 10^4$ cu. ft. gas. Calculation C-4.

= $105

4.	Remarks	.1	Energy Conservation Opportunity.
		.2	Solar heat gain has not been included in the above calculations.

32. Lobby Ventilation System F-2

1. Situation

.1 The lobby unit is controlled by a Johnson Controls pneumatic control system.

.2 The system consists of a supply unit having both return air and outside air providing heating and ventilation to the space. Exhaust is handled through an ancillary exhaust fan.

.3 The control system is supposed to operate through a day/night switch located in the manager's office.

Day Operation

The fan runs continuously. The return air and outside air dampers are manually controlled. The exhaust fan is designed to operate, but is overriden by the circuit breaker. The exhaust fan supposed by causes drafts and noise complaints.

The heating coil bypass dampers are controlled by a room thermostat.

Night Operation

The outside air damper is closed and the heating coil bypass dampers are set on 100% heating. The fan cycles to maintain the space temperatures of the night thermostat.

In practise night operation appears to be seldom used.

.4 Washroom exhaust fans run continuously.

.5 The area contains a freeze stat which will send an alarm to the fire department if lobby temperatures get too low.

.6 The outside air dampers are not low leakage dampers. They probably leak at least 30%.

32. Lobby Ventilation System F-2 (Cont'd)

2. Solution

.1 Replace day/night switch with a three position switch.

High occupancy day
Low occupancy day
Night cycle

High Occupancy Day

Fan to run continuously.

Add new mixed air temperature control to set return and outside air dampers to provide 55°F mixed air temperature.

Heating to be controlled by room thermostat.

Washroom exhaust fans to be on.

Underseat exhaust fans to be on.

Low Occupancy Day

Fan to run intermittently to provide heating as required by thermostat.

Outside air dampers to be closed.

Washroom exhaust fan to be on.

Underseat exhaust fan to be off.

Night Cycle

Fan to run intermittently to provide heating as required by thermostat.

Outside air dampers to be closed.

Washroom exhaust fans to be off.

Exhaust fan to be off.

Underseat - Operate on night cycle as often as possible.

Estimated Cost: $4,000. Class IV.

32. Lobby Ventilation System F-2 (Cont'd)

2. Solution (Cont'd)

.2 Replace underseat exhaust fan with a lower volume cabinet centrifugal exhaust fan. Redesign exhaust fan. Redesign exhaust air volumes to match present needs. A centrifugal cabinet fan will have much lower noise levels then the present fan.

Estimated Cost: $6,000 Class III.

.3 Replace outside air dampers with low leakage dampers.

Estimated Cost: $1,000. Class III.

.4 Provide a 4 hour run timer to switch unit automatically from high occupancy day cycle to low occupancy day cycle after 4 hours unless reset.

Estimated Cost: $500. Class IV.

.5 Consider providing steam radiation to heat the space. This would change the low occupancy day cycle and night cycle so that the fan would not start.

.6 Total Estimated Cost: $11,500.

3. Savings

.1 Assume high occupancy on 8 hrs., low occupancy 4 hrs., night 12 hrs./day.

.2 Reduced outside air:

$$= (5600)\ (30\%)\ \left(\frac{12+4 \text{ hrs}}{24}\right)\ (10970)\ (24)\ (.7)/1000$$

= 206,411 CF gas. Calculation C-4.
= $617 Class III

.3 Reduced fan motor consumption:

= (3 hp) (1kW/hp) (12 hrs) (250)
= 9000 kWh. Calculation C-1.
= $167 Class III

.4 Total Annual Energy Savings: 6.97×10^4 EKWH
Total Annual Dollar Savings: $784

Remarks

.1 Energy Conservation Opportunity.

.2 The installation of a refrigerated air dryer in the control air as suggested for the Arena Air Handler will also improve control in this unit.

33. Changeroom Door Closers

1.	Situation	.1	Warm air from the dressing rooms escapes to the unheated corridor through doors normally left open.
2.	Solution	.1	Install door closers on all heated rooms off the east corridor.
		.2	Estimated Cost: $100 ea. Class II.
3.	Saving	.1	Increased comfort through warmer changerooms.
		.2	Reduced heat loss - not calculated.
4.	Remarks	.1	Maintenance Item.

34. Refrigerated Control Air Dryer

1. Situation
   - .1 Control air line run into the cold arena area.
   - .2 At present there is no air dryer on this system.
   - .3 Without installation of air dryer on the control air system, control air line in the arena area could freeze up and render the system inoperable.
2. Solution
   - .1 Install a mechanical refrigerated air dryer. This reduces dew point of the compressed air, therefore reducing the possibility of frozen control line.
   - .2 Estimated Cost: $2000 Class III.
3. Savings
   - .1 Not calculated.
4. Remarks
   - .1 Operation Item. Should be installed to enable complete control system to be operable.

35. Concrete Block Sealer

1. Situation

.1 Exterior of concrete block wall has never been seal coated. Infiltration through the block wall is high. In some areas, daylight can be seen through the block.

2. Solution

.1 Apply two coats of spray on block sealer to the entire building block exterior.

.2 Estimated Cost: $7600 (@$.40/sq.ft.) Class IV.

3. Saving

.1 Reduced infiltration through the exterior block wall:

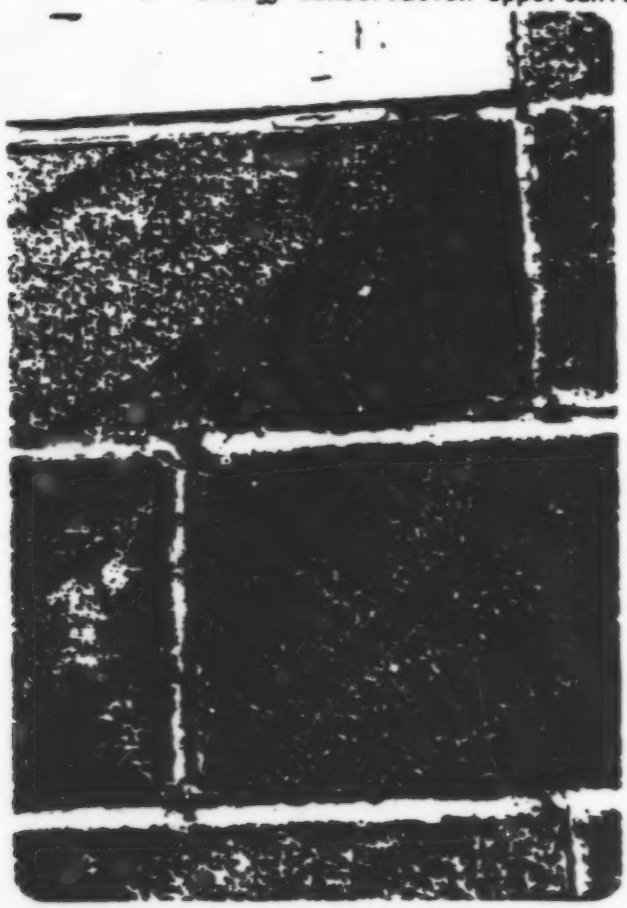
Rink Area = (3-0.1 cfh/ft²) (.018) (11980 ft²) (1.1/60) (5650) (24) (.7)/1000
= 5.9×10^4 C.F. Calculation C-3

Other = (3-0.1 cfh/ft²) (.018) (4530 ft²) (1.1/60) (10970) (24) (.7)/1000
= 4.3×10^4 C.F. Calculation C-3.

.2 Total = 1.03×10^5
= $307

4. Remarks

.1 Energy Conservation Opportunity.



36. Infrared Heaters in Arena Area

1. Situation
   - .1 Arena Ventilation Unit F-1 operates during spectator occupied periods.
   - .2 Spectator occupancy comform now requires the Arena Ventilation Unit F-1 to operate.
2. Solution
   - .1 Install electric infrared heaters for comfort of spectator during low occupancy periods.
   - .2 Arena Ventilation Unit operating period may be reduced by 50% of the time.
   - .3 Cost: $400 per unit. Assume 2 units. Class III estimate.
3. Saving
   - .1 Electrical saving with F-1 unit shut down:

     = (18,500) (1.1) (5,650) (24) (.7) (.5)/1000
     = 966,000 cu. ft. gas. Calculation C-3.
     = $2,900

   - .2 Electrical saving with F-1 unit shut down:

     = (10) (1) (.50) (2000)
     = 10,000 kWhr. Calculation C-1
     = $186

   - .3 Electrical energy consumption with infrared heater. Assume two 5 kW heaters. This cancels out Item 2.
   - .4 Total Saving: $2,900.
4. Remarks
   - .1 Energy Conservation Opportunity.